

Design Intent Tool

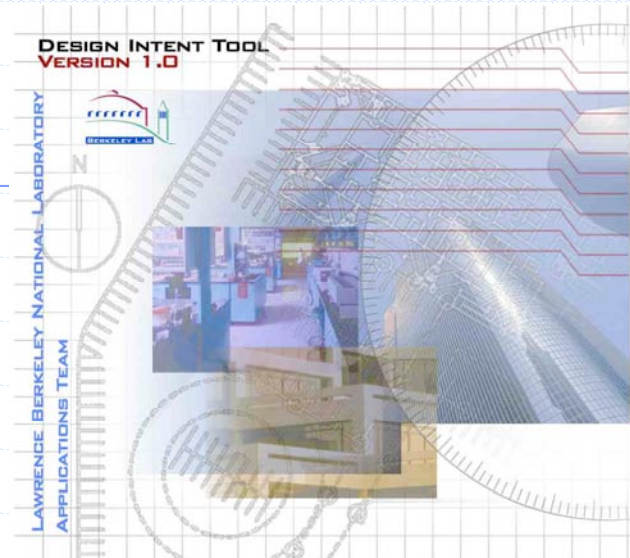
Facilitating collaboration &
lifecycle information management
in energy-efficient buildings

Lawrence Berkeley National Laboratory • Applications Team

Sponsored by the California Energy Commission

Presentation to Labs21

Dale Sartor & Evan Mills





Labs21 Design Support Tools

An Overview

Labs21 Design Support Tools

*Lab Design Guide
Reference Manual
& How-to Manual*

Online guidance on how to **implement** high performance strategies

*Design Intent
Tool*

A database tool to **document** intended strategies and metrics during design

*Environmental
Performance Criteria*

A point-based system to **rate** overall sustainability

*Benchmarking
Tool*

A web-based database tool to **compare** energy performance across facilities

Lab Design Guide – Reference Manual

The screenshot shows a software application window titled "Main window". The window has a blue title bar with standard window controls (minimize, maximize, close) on the right. Below the title bar is a toolbar with icons for "Hide", "Back", "Forward", "Print", and "Options". Below the toolbar is a tabbed interface with tabs for "Contents", "Index", "Search", and "AnswerHelp". The "Contents" tab is active, showing a tree view of the application's structure. The tree view includes categories like "Overview", "Architectural Programming", "Right Sizing: Choosing an Energy-Efficient", "Direct Digital Control (DDC)", "Supply Systems", "Exhaust Systems", "Distribution Systems", "Air Filtration", "Cleanroom filtration", "Filter Pressure Drop", "Electronic vs. Media Filtration", "Lighting", and "Commissioning". Under "Air Filtration", there is a sub-category "Degree of Filtration" which includes "Filtration overview" and a list of topics: "Filter processes", "Filter performance", "Filter power calculation" (highlighted), "Filter construction", "Impingement filters", "Extended surface filters", "HEPA filters", "Bacteria removal", "Mounting and location", "Filtration application-checklist", and "Filtration arrangement-checklist".

Filter power calculation

Avery (1973), as cited in the [NAFA Guide to Air Filtration \(1993\)](#), discusses calculation of the power requirement for a filter bank:

The energy used to overcome the resistance of a filter bank is provided by the blower which is part of the HVAC system. The blower, in turn, gets its energy from a motor. It is rare that this motor is not an electric motor so that the energy it uses is in the form of kilowatts.

The formula for air horsepower is:

$$hpa = (CFM \times TP) / 6358$$

Where:

hpa = Air horsepower required to overcome filter system resistance

CFM = Quantity of air being filtered expressed in cubic feet per minute.

TP = Total pressure of filter system (in. w.g.)


Total pressure is the sum of static pressure and velocity pressure. Since the filter media velocity is low, the velocity pressure can be ignored. For this reason, the equation can be written as:

$$hpa = (CFM \times SP) / 6358$$

Lab Design Guide – How-to Manual

(under development)

File Edit View Favorites Tools Help


LABS FOR THE 21ST CENTURY

Lab Design Guide: How-to Manual

The How-to Manual provides “step-by-step” guidance on energy efficiency and sustainability measures at various phases of the design process, from pre-design, through design development, construction and occupancy. The manual emphasizes energy efficiency and sustainability measures that are especially relevant in laboratories. More general measures (e.g. efficient lighting in office spaces in laboratory buildings) are briefly mentioned but not detailed, since these are well covered in other referenced resources.

Process

Start here. This section lists a series of process-related action items for each stage of the design process

Strategies

This section describes how to implement objectives and strategies, with action items for each design stage

This manual should be used in conjunction with the following Labs21 tools:


Lab Design Guide-Reference: This serves as a detailed reference for the How-to Manual, and provides links to the Reference. There is some overlap of content to facilitate the linkages.

Lab Design Intent Tool: The design intent documentation tool should be used to document and track energy, efficiency objectives, strategies used to achieve objectives, and performance metrics to measure success.

Benchmarking Tool: The benchmarking tool should be used to set targets and benchmark energy performance.

Environmental Performance Criteria: The EPC should be used to document and track the overall rating of the laboratory as the design progresses.

File Edit View Favorites Tools Help


LABS FOR THE 21ST CENTURY

Low Pressure Drop Coils

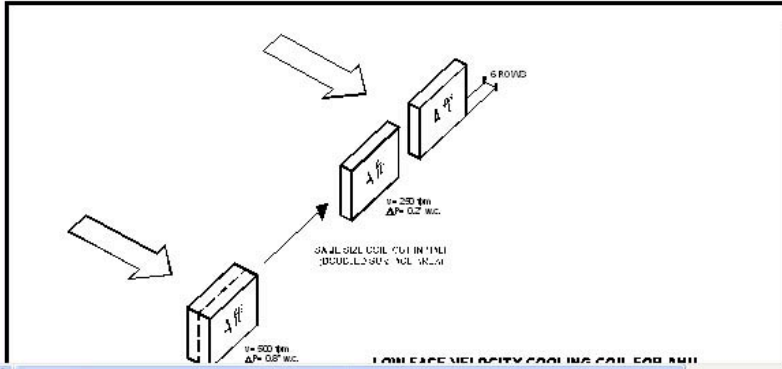
Adapted from “How Low Can you Go? Low Pressure Drop Laboratory Design”, by Dale Sartor, John Weale

[Description](#)
[Costs and Benefits](#)
[Applicability](#)
[Action Items](#)
[Benchmarks and EPC](#)
[References](#)

Description

Traditional air handler design for office buildings sets the size of the air handler based on a face velocity of 500 fpm. Originally based on balancing the first cost with the lifetime energy cost of equipment, this decades-old rule of thumb face velocity was never intended for sizing a unit that operates 8,760 hour per year, and is now rather questionable even for sizing standard modern office units. The reason the face velocity is so important is it has a direct impact on the energy consumption of the air handler.

By selecting a lower face velocity, the pressure drop of the air handling unit, and the proportional energy consumption, is reduced. As described in the picture below, a reduction in the face velocity reduces the power requirement by the square of the velocity reduction, for example a 25% reduction in face velocity yields a 44% reduction in power requirement.



Benchmarking Tool

(under development)

Labs21 Benchmarking Database Data Collection Form v0.1

[Go to Main Page](#)

- * Priority 1 Data
- * Priority 2 Data
- Priority 3 Data

	Value	Comment/Explanation
General Facility Data		
* Facility Name	Fred Hutchinson Cancer Research Center	
* Street Address	1100 Fairview Ave.	
* Location	Seattle, WA	
* ZIP Code	98109	
* Lab Use	Research/Development	
* Lab Type	Biological	
* Lab Category	Wet Lab	
* Number of Buildings	3	Phase 1 has 2 bldgs, and phase 2 has 1 bldg
* Gross Area (sq.ft)	532,602	
* Lab Area (sq.ft)	105,665	
Weekday Occupancy Hours	11	8 am to 7 pm is regarded as "occupied hours"
Year built	1997	phase 1 in 1993, phase 2 in 1997
Energy Use Data		
* Annual Energy Utility Costs (\$)	1,390,091	\$2.61/ gross sf (utility bill data)
* Ann. Heating Energy (therms)	963,667	utility bill data
Does facility use CHP (Cogen) system?		
Annual Electricity Use (kWh)		
* Total building(s)	41,010,354	based on design data, actual for 2000-2001 was 25,937,717
* Ventilation	19,067,152	based on design data
* Cooling Plant	4,686,898	based on design data
Lighting	3,408,653	based on design data
Process/plug	13,847,652	based on design data
Peak demand (kW)		

System	Energy Use Metrics	Efficiency Metrics
Ventilation	kWh/sf-yr	Peak W/cfm Peak cfm/sf (lab) Avg cfm/peak
Cooling	kWh/sf-yr	Peak W/sf Avg kW/ton Peak tons/sf
Lighting	kWh/sf-yr	Peak W/sf
Process/ Plug	kWh/sf-yr	Peak W/sf
Heating	BTU/sf-yr	Peak W/sf Utility \$/sf-yr
Aggregate	kWh/sf-yr BTU/sf-yr (source)	Effectiveness (Ideal BTU/ Actual BTU)

Design Intent Tool

Design Intent Tool 1.0 - [LabsExample1]

File

Introduction | Manage Project Files | Manage Template Files | User Guide | Feedback | Help | Web Home Page

Design Intent Document | Owner's Goals & Project Info | Team Contact Info | Reports

DESIGN INTENT TOOL
VERSION 1.0

Design Intent Tool Version 1.0
Project Name: LabsExample1
Owner:
Today's Date: 09-10-2002

Select Design Area

+/- Add/Remove

- ☐ General
- ☐ Architectural: Loads
- ☒ Mechanical: Ventilation System
- ☐ Mechanical: Chiller Plant
- ☐ Mechanical: Heating Plant
- ☐ Electrical: Lighting System
- ☐ Electrical: Distribution System
- ☐ Electrical: Renewable/Distribut
- ☐ Process: Process/Plug Loads
- ☐ Operations and Maintenance

Design Area Description

The mechanical ventilation system consists of air-handling units (fans, filters, heating and/or cooling coils, etc.), supply ductwork, terminal devices for controlling temperature and/or pressure in the zones, exhaust and return-air ductwork, exhaust

Select Objective

+/- Details Click this button to add, remove or edit Objectives for this project

Objective Name	Objective Description
Maximize average efficiency	
Maximize full-load efficiency	Maximizing full-load efficiency involves minimizing the power requirements imposed by the system components and maximizing the efficiency of the equipment providing the ventilation.
Maximize part-load efficiency	

Strategies

+/- Details Click this button to add, remove or edit Strategies for the Objective selected above.

Index	Strategy Name	Strategy Description
1	Efficient Fans	Efficient fans (typically airfoil or vaneaxial) convert more of the input shaft power to flow and pressure in the airstream. In addition to the fan itself, the inlet and discharge conditions are critical to good fan performance.
2	Efficient Motors	Although motors are relatively efficient converters of electrical to mechanical energy, choosing the most-efficient motor for the application is typically very cost-effective. DOE maintains the "MotorMaster" database of motor efficiency, which is valuable for
3	Efficient Mechanical Drives	Mechanical drives include belts, couplings, shafts, and gearboxes. Cogged or synchronous belts are more efficient than standard V-belts. With variable-speed inverters, many applications can be driven directly, eliminating belt energy losses and maintenance altogether.

Metrics

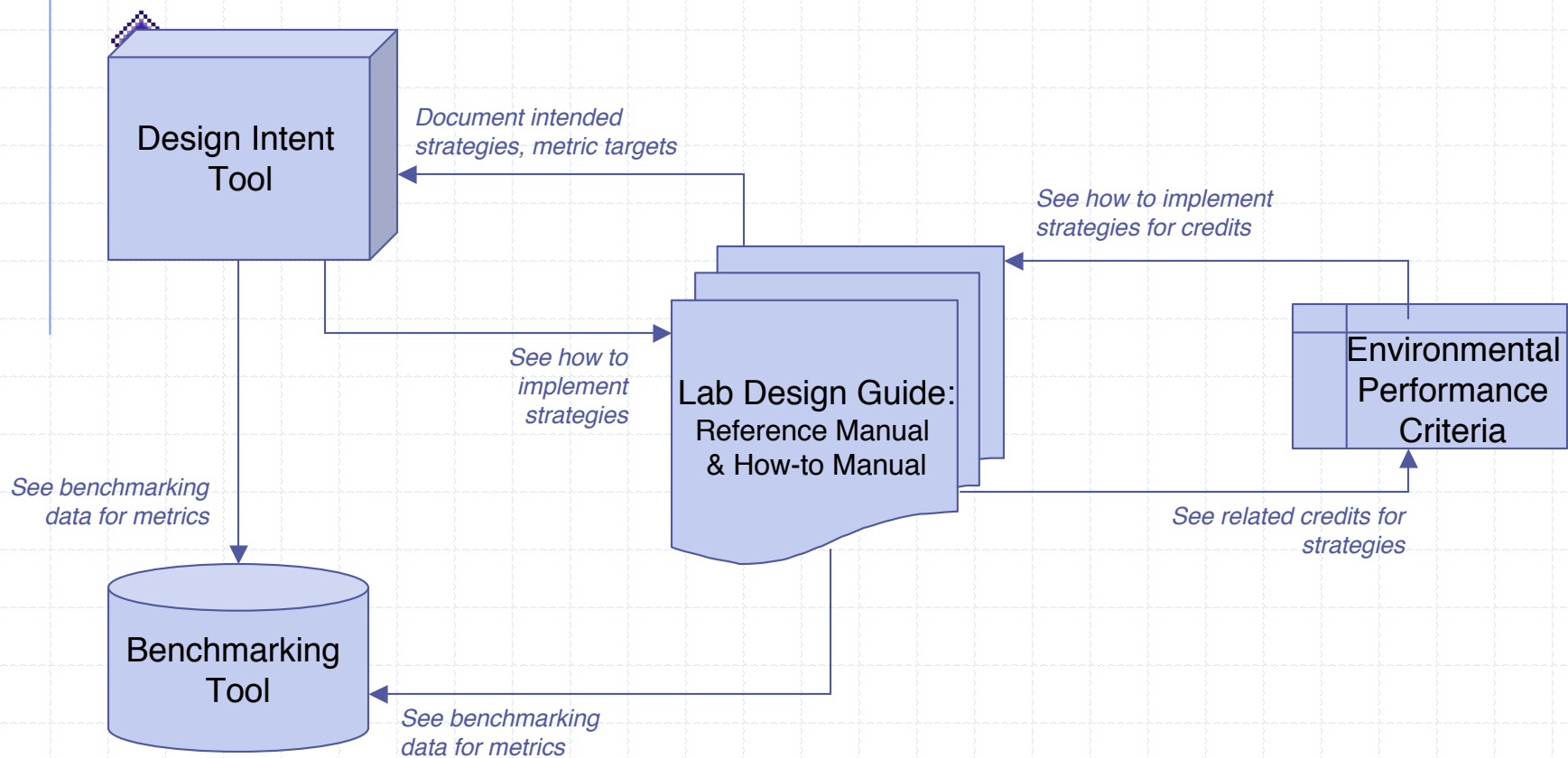
Assessment Records Click this button to view and edit Assessment Records for the Objective selected above.

Index	Metric Name	Metric Description	Target	Units
1	Peak total (all fans) W/cfm	The sum of the electrical power (W) used for all ventilation fans at design conditions divided by their total design air flow (cfm).	1.3	W/cfm
2	See metric for strategy 2 (overall air-handling unit).			

Form View

NUM

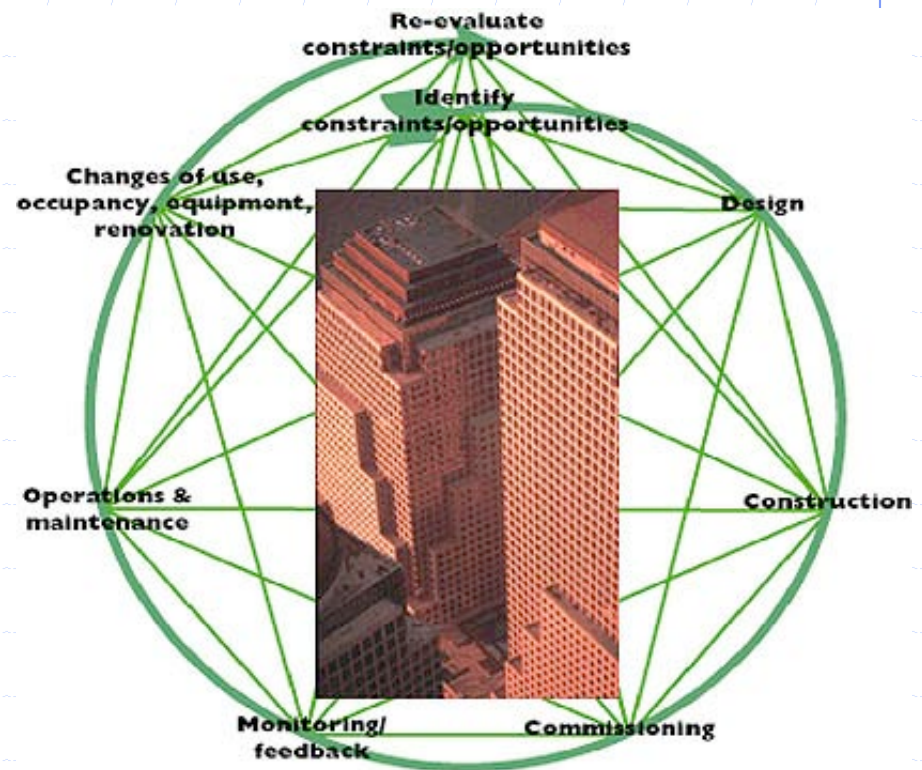
Links Among the Tools



Design Intent Documentation

- ◆ Today's design intent documentation is fragmented, at best.
- ◆ Value:
 - v Consolidates, preserves, updates information
 - v Engages owner & team
 - v Avoids misunderstandings
 - v Supports commissioning
 - v Establishes and tracks performance targets
 - v Enhances energy savings, O&M, M&V

Building Lifecycle

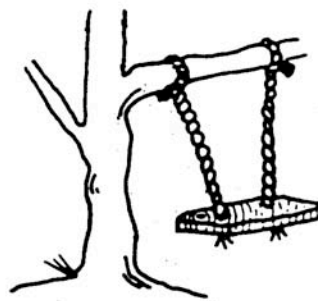


Challenges

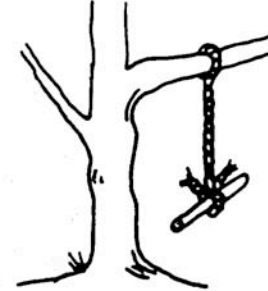
- ◆ Effective owner involvement
- ◆ Highly diverse user audiences
- ◆ Tension between brevity and comprehensiveness
- ◆ Integrating with existing design culture
- ◆ Resistance to documentation

If it Wasn't So True, it Would Be Funny

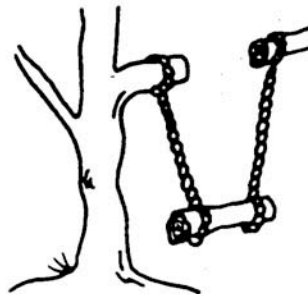
What the user really wanted



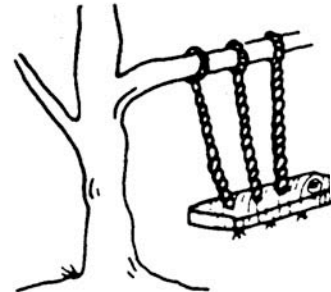
What the user asked for



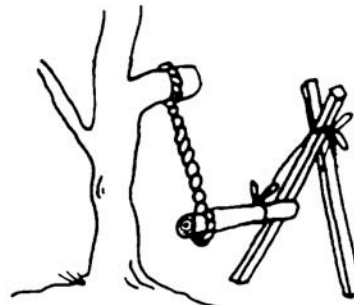
How the analyst saw it



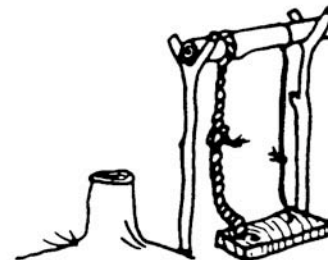
How the system was designed



As the contractor built it



How it actually works (Mondays)



Approach

◆ Structure

- √ Design Areas

- ω Objectives - overall goals

- √ Strategies - methods for achieving goals

- √ Metrics - how to confirm/verify performance

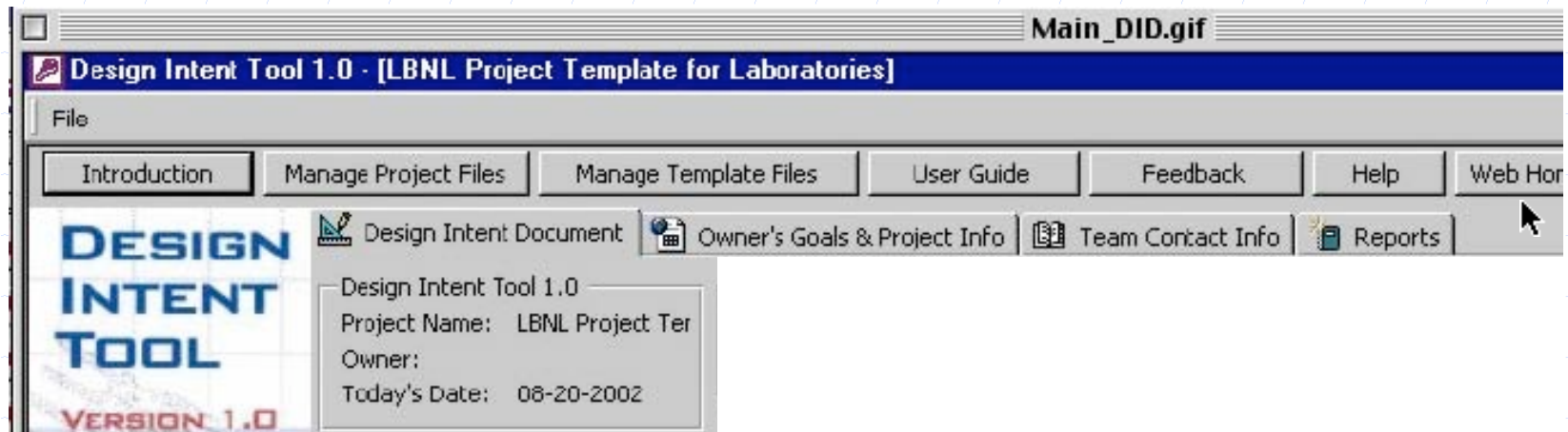
◆ Database-driven, Access2000, Outputs to Word & Excel

◆ Templates from LBNL (Labs; LEED Bldgs)

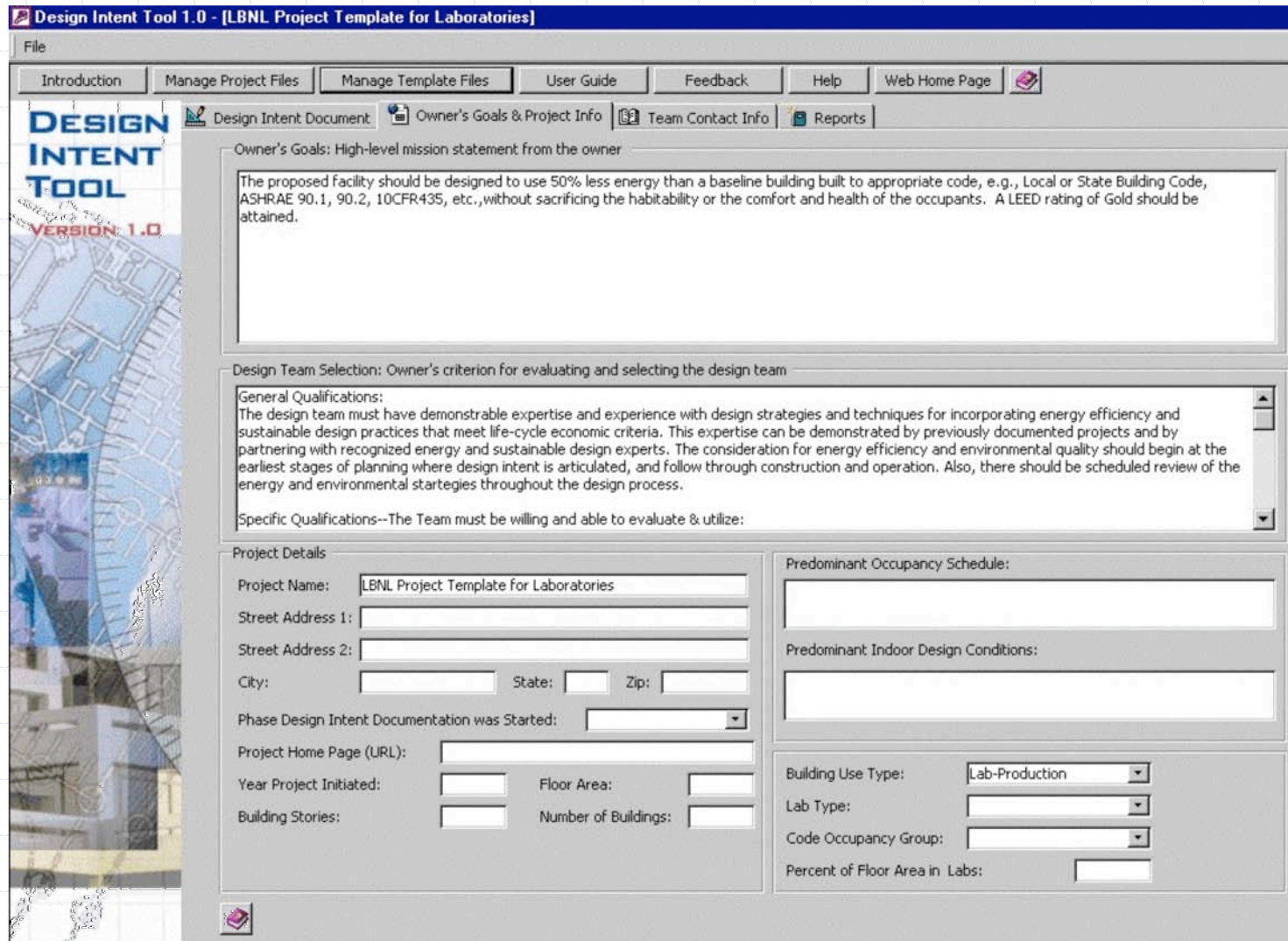
◆ Web connectivity

◆ “Local” content (e.g. EE Labs Design Guide)

Navigation



Owner's Goals



Design Intent Tool 1.0 - [LBNL Project Template for Laboratories]

File

Introduction | Manage Project Files | Manage Template Files | User Guide | Feedback | Help | Web Home Page

Design Intent Document | **Owner's Goals & Project Info** | Team Contact Info | Reports

DESIGN INTENT TOOL
VERSION 1.0

Owner's Goals: High-level mission statement from the owner

The proposed facility should be designed to use 50% less energy than a baseline building built to appropriate code, e.g., Local or State Building Code, ASHRAE 90.1, 90.2, 10CFR435, etc., without sacrificing the habitability or the comfort and health of the occupants. A LEED rating of Gold should be attained.

Design Team Selection: Owner's criterion for evaluating and selecting the design team

General Qualifications:
The design team must have demonstrable expertise and experience with design strategies and techniques for incorporating energy efficiency and sustainable design practices that meet life-cycle economic criteria. This expertise can be demonstrated by previously documented projects and by partnering with recognized energy and sustainable design experts. The consideration for energy efficiency and environmental quality should begin at the earliest stages of planning where design intent is articulated, and follow through construction and operation. Also, there should be scheduled review of the energy and environmental strategies throughout the design process.

Specific Qualifications--The Team must be willing and able to evaluate & utilize:

Project Details

Project Name: LBNL Project Template for Laboratories

Street Address 1:

Street Address 2:

City: State: Zip:

Phase Design Intent Documentation was Started:

Project Home Page (URL):

Year Project Initiated: Floor Area:

Building Stories: Number of Buildings:

Predominant Occupancy Schedule:

Predominant Indoor Design Conditions:

Building Use Type: Lab-Production

Lab Type:

Code Occupancy Group:

Percent of Floor Area in Labs:

UC Merced UC Merced Science & Engineering Building Case Study

- ◆ 166,000 sq.ft. Teaching/Research Lab

- ◆ Owner's Goals

- √ The proposed facility should be designed to use 20% less energy than a baseline building, without sacrificing the habitability or the comfort and health of the occupants. A LEED rating of Silver should be attained.

Design Intent Document

Design Intent Tool 1.0 - [LBNL Project Template for Laboratories]

File

Introduction | Manage Project Files | Manage Template Files | User Guide | Feedback | Help | Web Home Page

Design Intent Document | Owner's Goals & Project Info | Team Contact Info | Reports

Design Intent Tool 1.0
Project Name: LBNL Project Ter
Owner:
Today's Date: 08-20-2002

Select Design Area
+/- Add/Remove

- ☒ General
- ☐ Architectural: Loads
- ☐ Mechanical: Ventilation System
- ☐ Mechanical: Chiller Plant
- ☐ Mechanical: Heating Plant
- ☐ Electrical: Lighting System
- ☐ Electrical: Distribution System
- ☐ Electrical: Renewable/Distribut
- ☐ Process: Process/Plug Loads
- ☐ Operations and Maintenance

Design Area Description
This area includes whole-building information or information pertaining to multiple design areas.

Select Objective
+/- Details Click this button to add, remove or edit Objectives for this project

Objective Name	Objective Description
Achieve high overall energy efficiency	Energy efficiency is low energy consumption to accomplish a given task. High overall efficiency is low whole-building energy use (electric energy, peak electric power demand, natural gas, and any other fuels) to provide a laboratory building of a certain

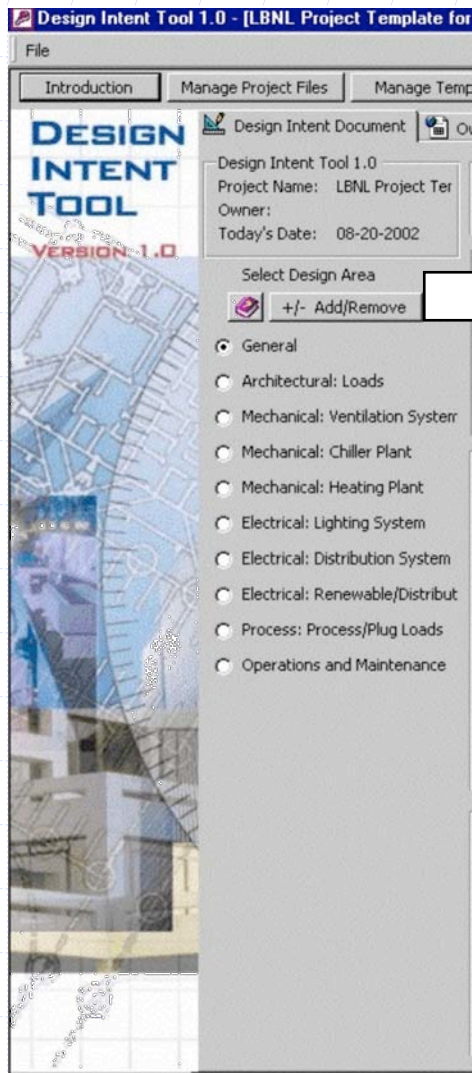
Strategies
+/- Details Click this button to add, remove or edit Strategies for the Objective selected above.

Index	Strategy Name	Strategy Description
1	Exceed Title 24 requirement by factor of 2.5 (energy use 40% of Title 24 budget)	Energy code requirements can typically be easily outperformed. Such requirements make a convenient baseline against which simulated performance can be compared. Title 24 is California's State Energy Code. Buildings can comply with the Code either by the prescriptive or
2	Achieve LEED Platinum rating	The Leadership in Energy and Environmental Design (LEED) system was created by the U.S. Green Building Council to comprehensively rate buildings for their environmental impact and sustainability. Platinum is the highest rating.
3	Minimize life-cycle cost	The life-cycle cost of a building is its total cost over its entire life, including design, construction, operation, maintenance, renovation, and decommissioning; future costs are discounted to present value for comparison. Minimizing life-cycle costs usually results in higher first

Metrics
Assessment Records Click this button to view and edit Assessment Records for the Objective selected above.

Index	Metric Name	Metric Description	Target	Units
1	Total annual kWh/sf	Whole-building electric energy use per gross square foot of building. From building electric meter.	?	
2	Annual source BTU/sf (combined gas and electric)	Whole-building total energy use per gross square foot of building. Source BTU/sf is calculated using XXX BTU/kWh of electricity and a	?	

Design Areas



frmDesign_Areas_Select : Form

Select the Design Areas you wish to use for this project from the available Design Areas section. If you wish to add, delete or edit Design Areas, click the +/- Manage Design Areas List button

Available Design Areas		Selected Design Areas
Sustainable Sites	>	General
Water Efficiency	>>	Architectural: Loads
Energy and Atmosphere	<	Mechanical: Ventilation System
Materials and Resources	<<	Mechanical: Chiller Plant
Indoor Environmental Quality		Mechanical: Heating Plant
Innovation and Design Process		Electrical: Lighting System
		Electrical: Distribution System
		Electrical: Renewable/Distributed Generatic
		Process: Process/Plug Loads
		Operations and Maintenance

* To select multiple Design Areas, simply keep the control (CTRL) key depressed while making your selections.

+/- Edit Design Areas List OK Cancel

Design Intent Tool 1.0 - [LBNL Project Template for...]

Index	Design Area Name	Design Area Description	Author	Date	Design Area URL	Comments
1	General	This area includes whole building information or information pertaining to multiple design areas.	Steve Greenberg			
2	Architectural: Loads	The Architectural Loads area includes elements of the building and its surroundings (envelope, furnishings, landscaping, etc.) that create or affect the loads put on the	Steve Greenberg			
3	Mechanical: Ventilation System		Steve Greenberg			
4	Mechanical: Chiller Plant		Steve Greenberg			
5	Mechanical: Heating Plant		Steve Greenberg			
6	Electrical: Lighting System		Steve Greenberg			
7	Electrical: Distribution System		Steve Greenberg			
8	Electrical: Renewable/Distributed Generation		Steve Greenberg			
9	Process: Process/Plug Loads		Steve Greenberg			
10	Operations and Maintenance		Steve Greenberg			
11	Sustainable Sites					
12	Water Efficiency					
13	Energy and Atmosphere					
14	Materials and Resources					
15	Indoor Environmental Quality					
16	Innovation and Design Process					

<< Back to Select Design Areas Add New Record Auto Update Dates

UC Merced - Design Areas

- ◆ General
- ◆ Architectural
- ◆ Mechanical: Ventilation
- ◆ Mechanical: Chiller (central plant)
- ◆ Mechanical: Heating (central plant)
- ◆ Electrical: Lighting
- ◆ Electrical: Distribution
- ◆ Process/Plug Loads
- ◆ Operation and Maintenance
- ◆ Energy Monitoring and Controls (added)

Objective Details

Design Intent Tool 1.0 - [Tbl_Lookup_Objectives]

File

Objective Record


Del	Index No	Objective Name	Objective Description	
<input checked="" type="checkbox"/>	1	Minimize Ventilation Loads	Apply architectural solutions to minimize the amount of ventilation air while meeting all fresh air, exhaust, heating, and cooling requirements.	
Author	Other	Objective URL	Update Date	Comments
			6/27/02	

Objective Record

Del	Index No	Objective Name	Objective Description	
<input checked="" type="checkbox"/>	2	Minimize Heating and Cooling Loads		
Author	Other	Objective URL	Update Date	Comments

Objective Record

Del	Index No	Objective Name	Objective Description	
<input checked="" type="checkbox"/>	3	Minimize Lighting Load		
Author	Other	Objective URL	Update Date	Comments
			6/27/02	

<<== Back to Main Design Intent Document Add New Objective Auto-Update Dates 

UC Merced - Key Objectives

◆ 26 “High Level” Objectives

◆ Key Objectives

- √ Achieve high overall energy efficiency
- √ Minimize ventilation loads
- √ Maximize average and MLM efficiency
- √ Minimize peak electric load
- √ Minimize simultaneous heating and cooling
- √ Assure ongoing performance

Strategy Details

Design Intent Tool 1.0 - [Tbl_Lookup_Objectives]

File

Strategy Record

Del	Index No	Strategy Name	Strategy Description
<input checked="" type="checkbox"/>	1	Exceed Title 24 requirement by factor of 2.5 (energy use 40% of Title 24 budget)	Energy code requirements can typically be easily outperformed. Such requirements make a convenient baseline against which simulated performance can be compared. Title 24 is California's State Energy Code. Buildings can comply with the Code either by the prescriptive or performance method. The prescriptive method means meeting specific requirements for different end-uses (e.g. lighting and ventilation) and construction
Author		CSI Number	Other
Strategy URL		Update Date	Comments

Strategy Record


Del	Index No	Strategy Name	Strategy Description
<input checked="" type="checkbox"/>	2	Achieve LEED Platinum rating	The Leadership in Energy and Environmental Design (LEED) system was created by the U.S. Green Building Council to comprehensively rate buildings for their environmental impact and sustainability. Platinum is the highest rating.
Author		CSI Number	Other
Strategy URL		Update Date	Comments

Strategy Record

Del	Index No	Strategy Name	Strategy Description
<input checked="" type="checkbox"/>	3	Minimize life-cycle cost	The life-cycle cost of a building is its total cost over its entire life, including design, construction, operation, maintenance, renovation, and decommissioning; future costs are discounted to present value for comparison. Minimizing life-cycle costs usually results in higher first costs and lower operating costs than are common for typical buildings.
Author		CSI Number	Other
Strategy URL		Update Date	Comments

Strategy Record

Del	Index No	Strategy Name	Strategy Description
<input checked="" type="checkbox"/>	4	Commission	Commissioning is the process of ensuring that building elements and systems are designed, installed, programmed, and adjusted to operate as intended. Ideally, the commissioning begins early in the design process, and continues throughout the life of the building.
Author		CSI Number	Other
Strategy URL		Update Date	Comments
		6/21/02	

<== Back to Main Design Intent Document Add New Strategy Auto-Update Dates 

UC Merced - Key Strategies

- ◆ Over 100 Strategies to Achieve Goals

- ◆ Key Strategies

- √ VAV fume hoods
- √ VFDs on fans and pumps
- √ Low pressure drop design (maybe)
- √ Evaporative precooling and process cooling
- √ Cooling coils in zones (no reheat)
- √ Central plant TES
- √ Ventilation and temperature reset (occ. sensor)

Assessment Record

Design Intent Tool 1.0 - [frmAssessmentRecord : Form]

File

Assessment Record

Metric Name: Target Value: Target Unit: Author:

Metric Description: General Assessment Method: Notes:

Measurement/Verification	Value	Assessor	Date	Verification Method
Pre-Design	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Schematic Design:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Design Development	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Contract (final design):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Bidding:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Construction (as built):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Project Closeout:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Assessment Record

Metric Name: Target Value: Target Unit: Author:


Metric Description: General Assessment Method: Notes:

Measurement/Verification	Value	Assessor	Date	Verification Method
Pre-Design	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Schematic Design:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Design Development	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Contract (final design):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Bidding:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Construction (as built):	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Project Closeout:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Assessment Record

Metric Name: Target Value: Target Unit: Author:

Metric Description: General Assessment Method: Notes:

< <== Back to Main Design Intent Document Auto-Update Dates 

UC Merced -- Key Metrics

		Target	
<u>Design Area:</u>	General		
Metric:	Total annual kWh/sf	33 kWh/sf	
Metric:	Annual peak W/sf	5.3 W/sf	
<u>Design Area:</u>	Architectural: Loads		
Metric:	Peak lab-only exhaust cfm/NSF	1 cfm/NSf	
<u>Design Area:</u>	Mechanical: Ventilation System		
<u>Design Area:</u>	Mechanical: Chiller Plant		
Metric:	Peak cooling tons/Ksf	2.9 tons/Ksf	
<u>Design Area:</u>	Mechanical: Heating Plant		
Metric:	Annual heating BTU/sf	150,000 BTU/sf	
Metric:	Peak heating BTU/hr/sf	34 btu/hr/sf	
<u>Design Area:</u>	Electrical: Lighting System		
Metric:	Peak lighting W/sf	1.1 W/sf	

Download

<http://ateam.lbl.gov/DesignIntent/home.html>

- ◆ New Templates
- ◆ User Guide
- ◆ Updates

